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Conceptual and Empirical Framework for Measuring Science Impact

Key ideas

Conceptual Framework

- Basic unit of analysis is individual scientists/teams
- Core outcome is creation, transmission and adoption of ideas
- Potential analytical framework is theory of the firm

Empirical Framework

- Leverage existing data and tools, particularly STAR METRICS and SciENCv
- Build analytical community (e.g. SciSIP)

Outline

- Motivation
- Approach: Doing an evaluation
- Conceptual Framework
- Empirical Framework
- Next steps

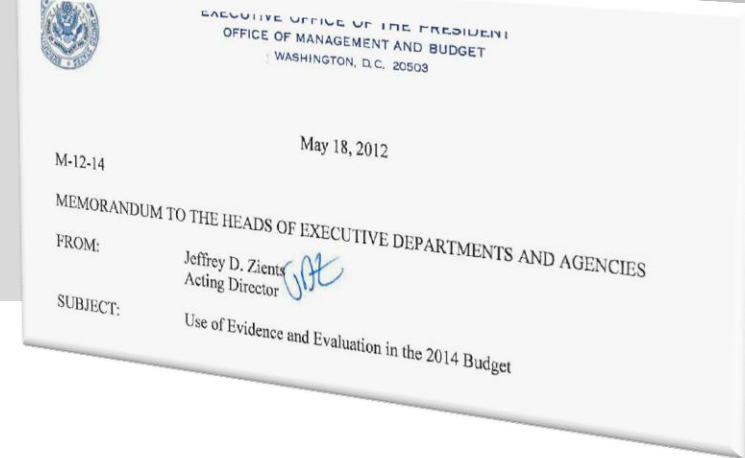
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Motivation

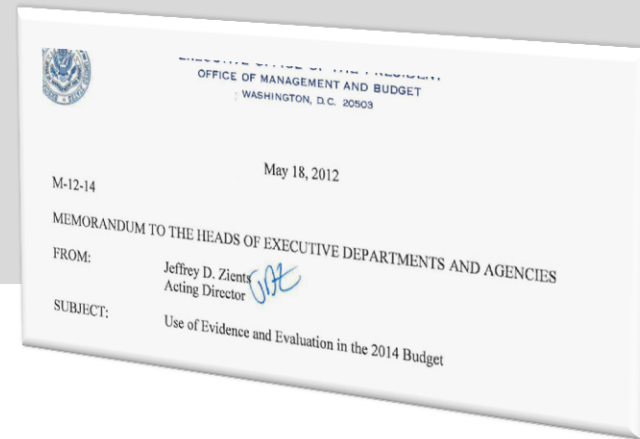
- Congressional and Administration interest in building a scientific basis for science policy
 - Science of Science Policy Interagency Group
 - NSF SciSIP program

Motivation



Agencies should demonstrate the use of evidence throughout their Fiscal Year (FY) 2014 budget submissions. Budget submissions also should include a separate section on agencies' most innovative uses of evidence and evaluation, addressing some or all of the issues below....

Motivation



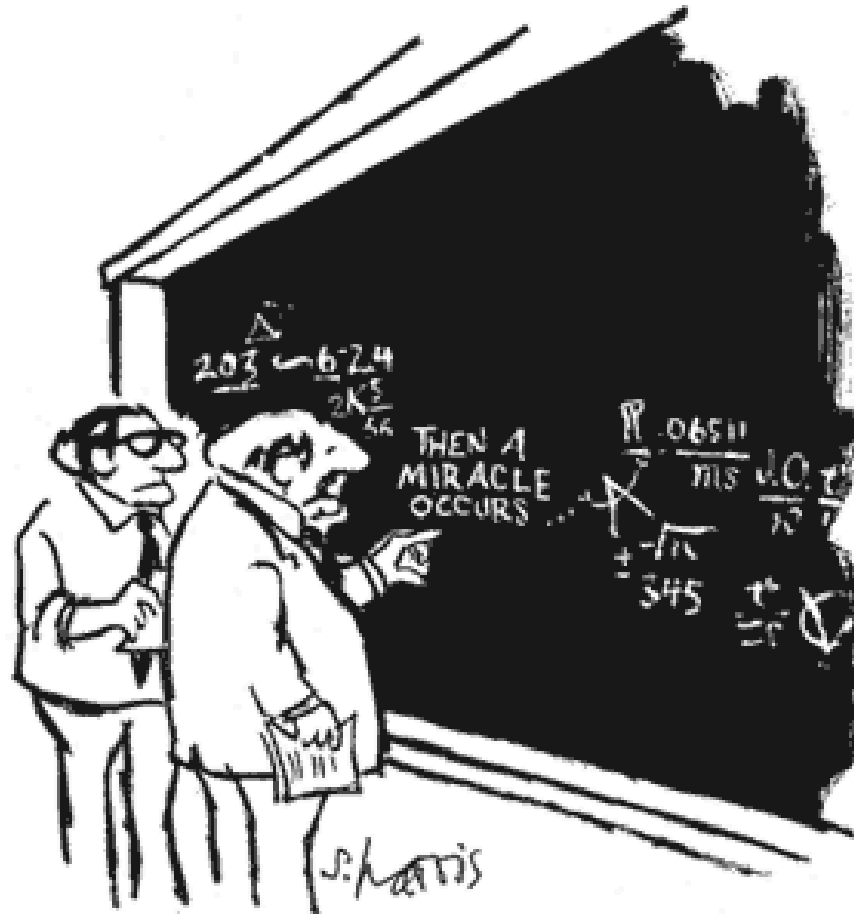
The Office of Science and Technology Policy has created a "community of practice" for agency personnel involved in designing and managing incentive prizes and has organized a Science of Science Policy working group that is developing tools aimed at establishing a more scientific, empirical evidence basis for science and technology policymaking.

Motivation

Competing Priorities in the Federal Budget...



Motivation: Buttressing Anecdotes



"I THINK YOU SHOULD BE MORE
EXPLICIT HERE IN STEP TWO."

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Impact Evaluation in Practice

Paul J. Gertler, Sebastian Martinez,
Patrick Premand, Laura B. Rawlings,
Christel M. J. Vermeersch

THE WORLD BANK

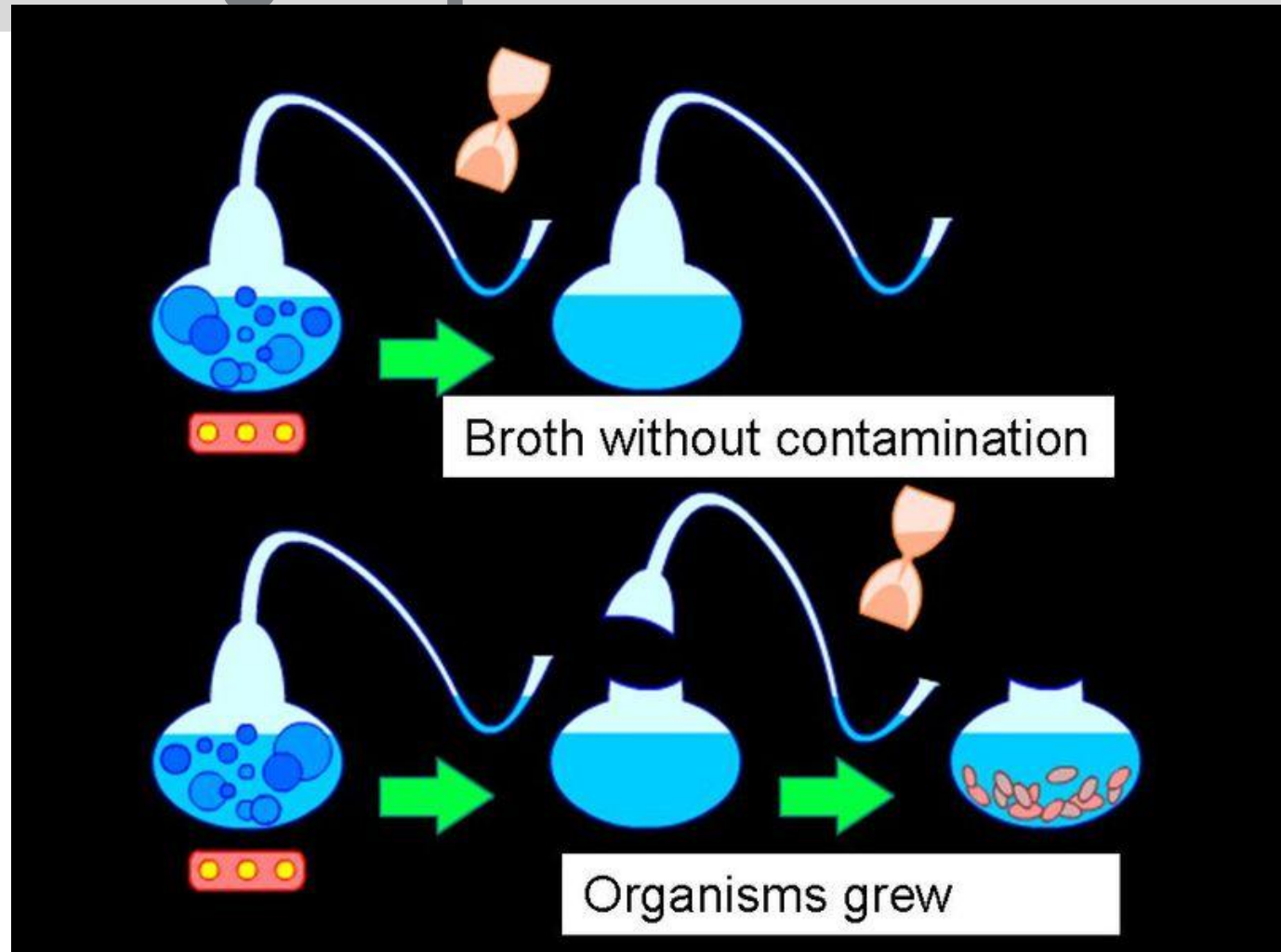
Classic Questions for Measuring Impact

What is the impact or causal effect of a program on outcome of interest?

Is a given program effective compared to the absence of the program?

When a program can be implemented in several ways, which one is the most effective?

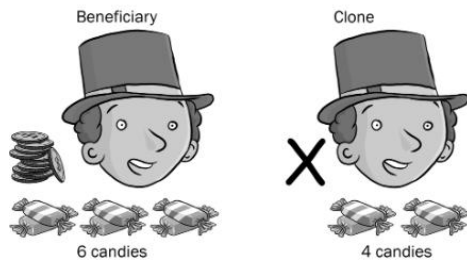
Classic Example: Measuring Impact



Classic Challenge: Identifying Counterfactual

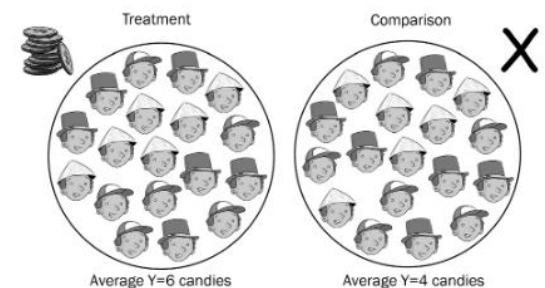
“A key goal of an impact evaluation is to identify a group of program participants (the treatment group) and a group of nonparticipants (the comparison group) that are statistically identical in the absence of the program.” World Bank

Figure 3.1 The Perfect Clone



Impact = 6 - 4 = 2 candies

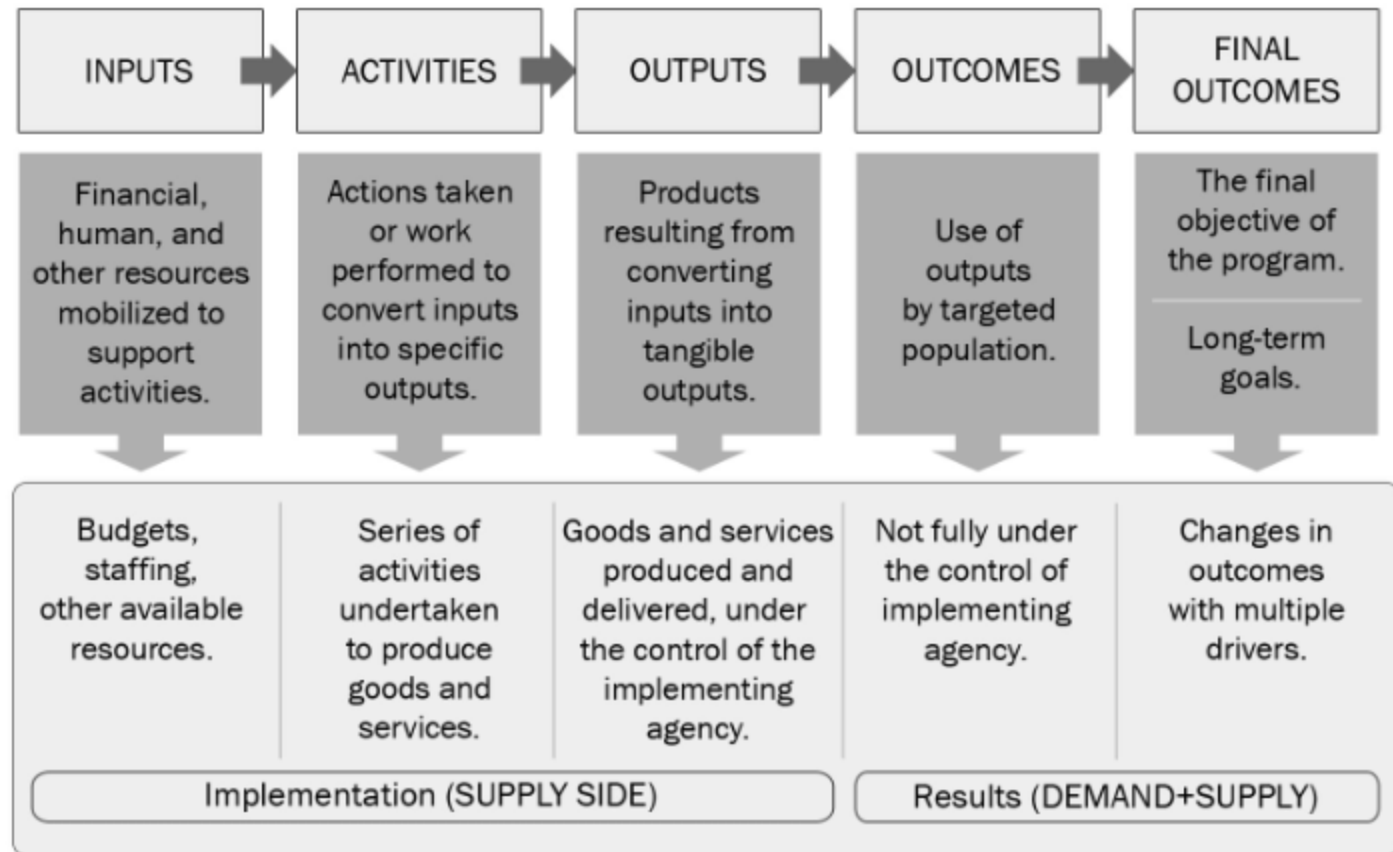
Figure 3.2 A Valid Comparison Group



Impact = 6 - 4 = 2 candies

Source: Authors.

Classic Challenge: Theory of Change

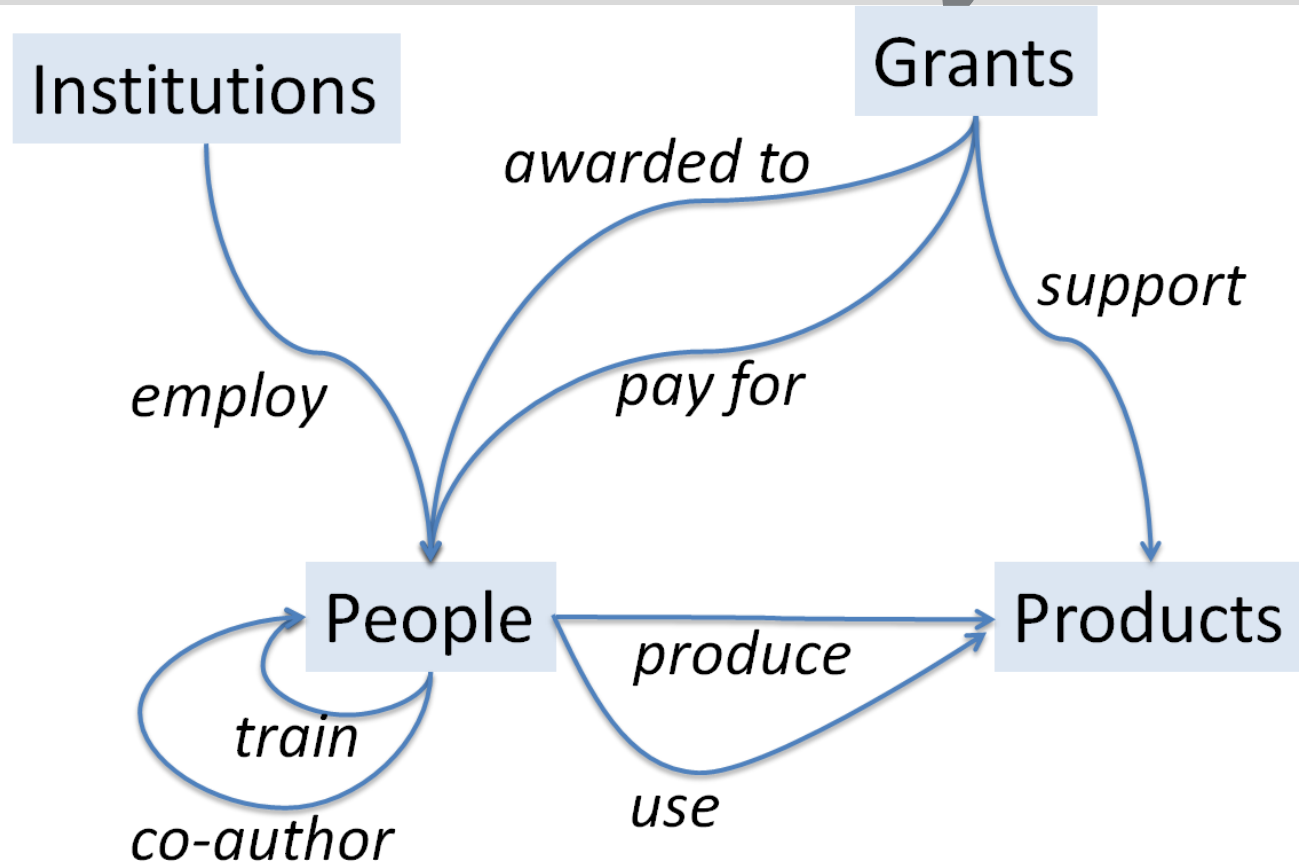


Source: Authors, drawing from multiple sources.

Outline

- Motivation
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Key Concept: Individual is basic unit of analysis



Core outcome is ideas

- Goal of project/firm: to create and transmit scientific ideas and push for their adoption (by other scientists, policy-makers or businesses)
- Behavioral Framework; Ideas are transmitted by workers in a variety of potentially measurable ways, including publications, presentations, blogs, internal project workspaces, and emails
- Behavioral Framework: Social networks/collaboration are a major vehicle whereby ideas are transmitted

Possible theory of Change: Theory of the firm

Repurposing the theory of the firm

$$Y = X \beta + \varepsilon$$

$$X = Z \varphi + \omega$$

Y – transmission of ideas

X - networks/collaborations

Z – level of funding

φ, β –

ε, ω - error terms

Outline

- Motivation
- Approach
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- Empirical Framework
- Analytical Framework
- Next steps

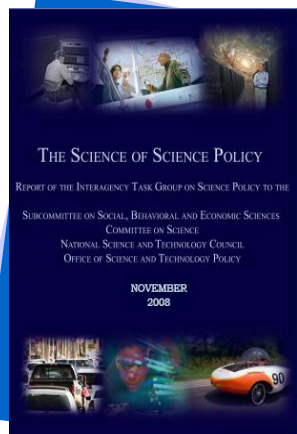
Challenge: The data didn't exist

The ITG undertook a literature review to determine the state of the science to date. A questionnaire was also circulated to Federal agencies to ascertain what methods are currently in use for programmatic investment decision making, as well as to ask what tools and resources are needed by Federal agencies that are currently unavailable. The ITG found that:

- There is a well developed body of social science knowledge that could be readily applied to the study of science and innovation.
- Although many Federal agencies have their own communities of practice, the collection and analysis of data about the science and scientific communities they support is heterogeneous and unsystematic.
- Agencies are using very different models, data and tools to understand their investments in science and technology.

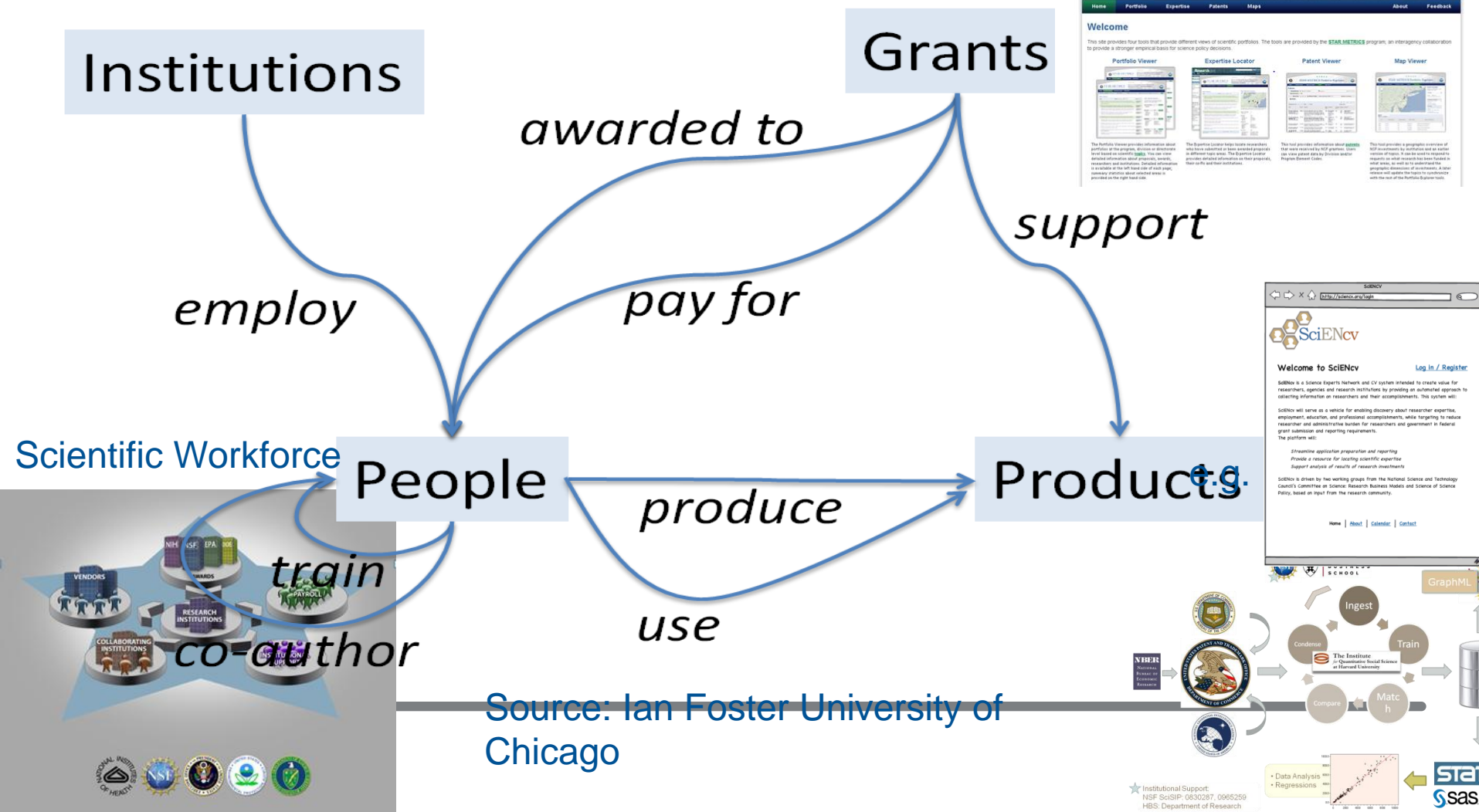
Data infrastructure is inadequate for decision-making.

THE SCIENCE OF SCIENCE POLICY: A FEDERAL RESEARCH ROADMAP



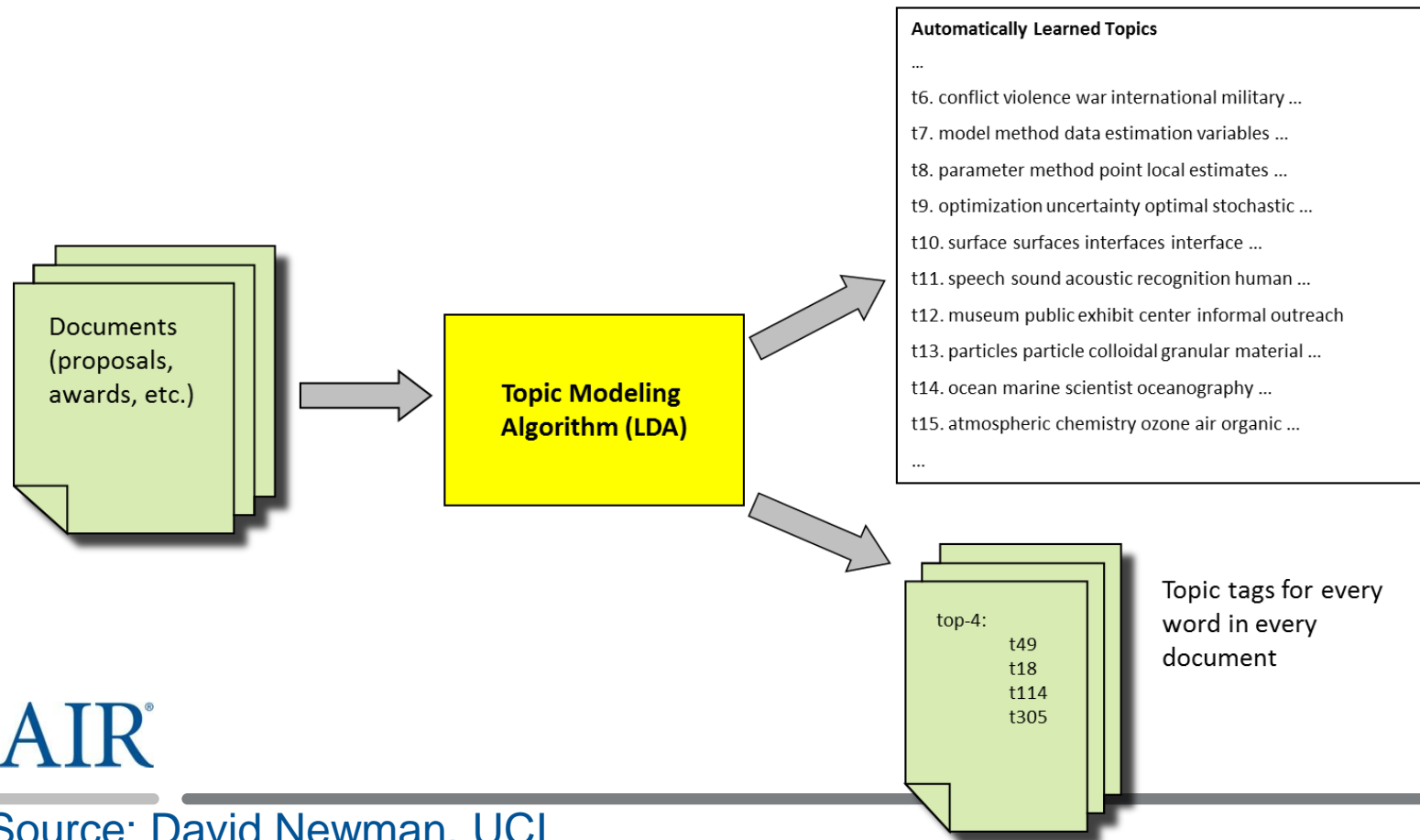
Leverage Existing Data

Portfolio Explorer

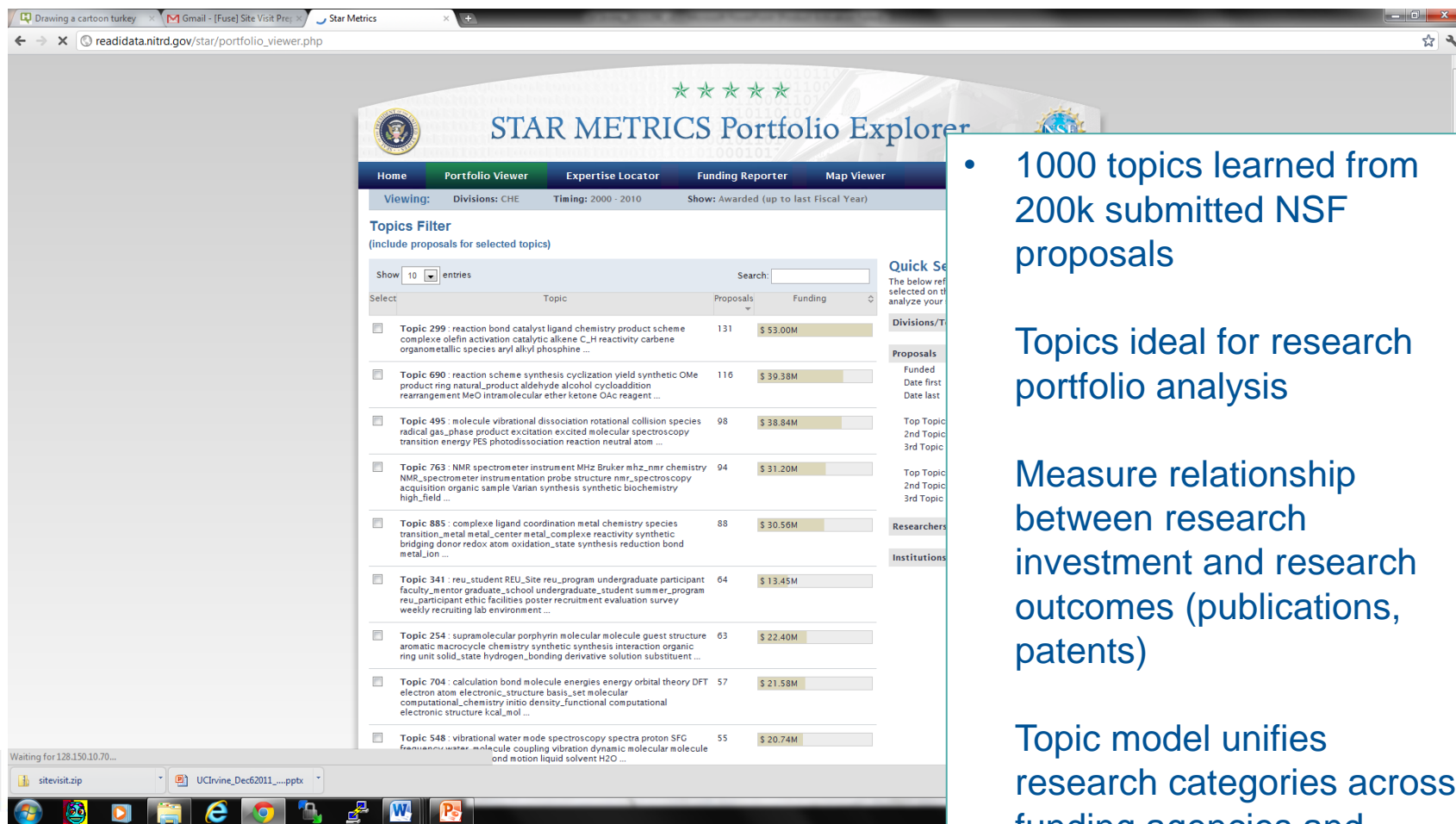


Leverage existing tools to capture ideas

Topic Modeling Process



Tools to capture level of funding



The screenshot shows the STAR METRICS Portfolio Explorer interface. The top navigation bar includes links for Home, Portfolio Viewer, Expertise Locator, Funding Reporter, and Map Viewer. The current view is 'Portfolio Viewer' for 'Divisions: CHE' and 'Timing: 2000 - 2010'. A 'Topics Filter' section allows users to select topics and view funding data. The main table lists various research topics, their proposal counts, and funding amounts.

Select	Topic	Proposals	Funding
<input type="checkbox"/>	Topic 299 : reaction bond catalyst ligand chemistry product scheme complex olefin activation catalytic alkene C-H reactivity carbene organometallic species aryl alkyl phosphine ...	131	\$ 53.00M
<input type="checkbox"/>	Topic 690 : reaction scheme synthesis cyclization yield synthetic OMe product ring natural_product aldehyde alcohol cycloaddition rearrangement MeO intramolecular ether ketone OAc reagent ...	116	\$ 39.38M
<input type="checkbox"/>	Topic 495 : molecule vibrational dissociation rotational collision species radical gas_phase product excitation excited molecular spectroscopy transition energy PES photodissociation reaction neutral atom ...	98	\$ 38.84M
<input type="checkbox"/>	Topic 763 : NMR spectrometer instrument MHz Bruker mh2_nmr chemistry NMR_spectrometer instrumentation probe structure nmr_spectroscopy acquisition organic sample Varian synthesis synthetic biochemistry high_field ...	94	\$ 31.20M
<input type="checkbox"/>	Topic 885 : complexe ligand coordination metal chemistry species transition_metal metal_center metal_complex reactivity synthetic bridging donor redox atom oxidation_state synthesis reduction bond metal_ion ...	88	\$ 30.56M
<input type="checkbox"/>	Topic 341 : reu_student REU_Site reu_program undergraduate participant faculty_mentor graduate_school undergraduate_student summer_program reu_participant ethic facilities poster recruitment evaluation survey weekly recruiting lab environment ...	64	\$ 13.45M
<input type="checkbox"/>	Topic 254 : supramolecular porphyrin molecular molecule guest structure aromatic macrocycle chemistry synthetic synthesis interaction organic ring unit solid_state hydrogen_bonding derivative solution substituent ...	63	\$ 22.40M
<input type="checkbox"/>	Topic 704 : calculation bond molecule energies energy orbital theory DFT electron atom electronic_structure basis_set molecular computational_chemistry initio density_functional computational electronic structure kcal_mol ...	57	\$ 21.58M
<input type="checkbox"/>	Topic 548 : vibrational water mode spectroscopy spectra proton SFG frequency water_molecule coupling vibration dynamic molecular molecule and motion liquid solvent H2O ...	55	\$ 20.74M

On the right side of the interface, there are sections for 'Quick Search', 'Divisions/T', 'Proposals', 'Researchers', and 'Institutions'.

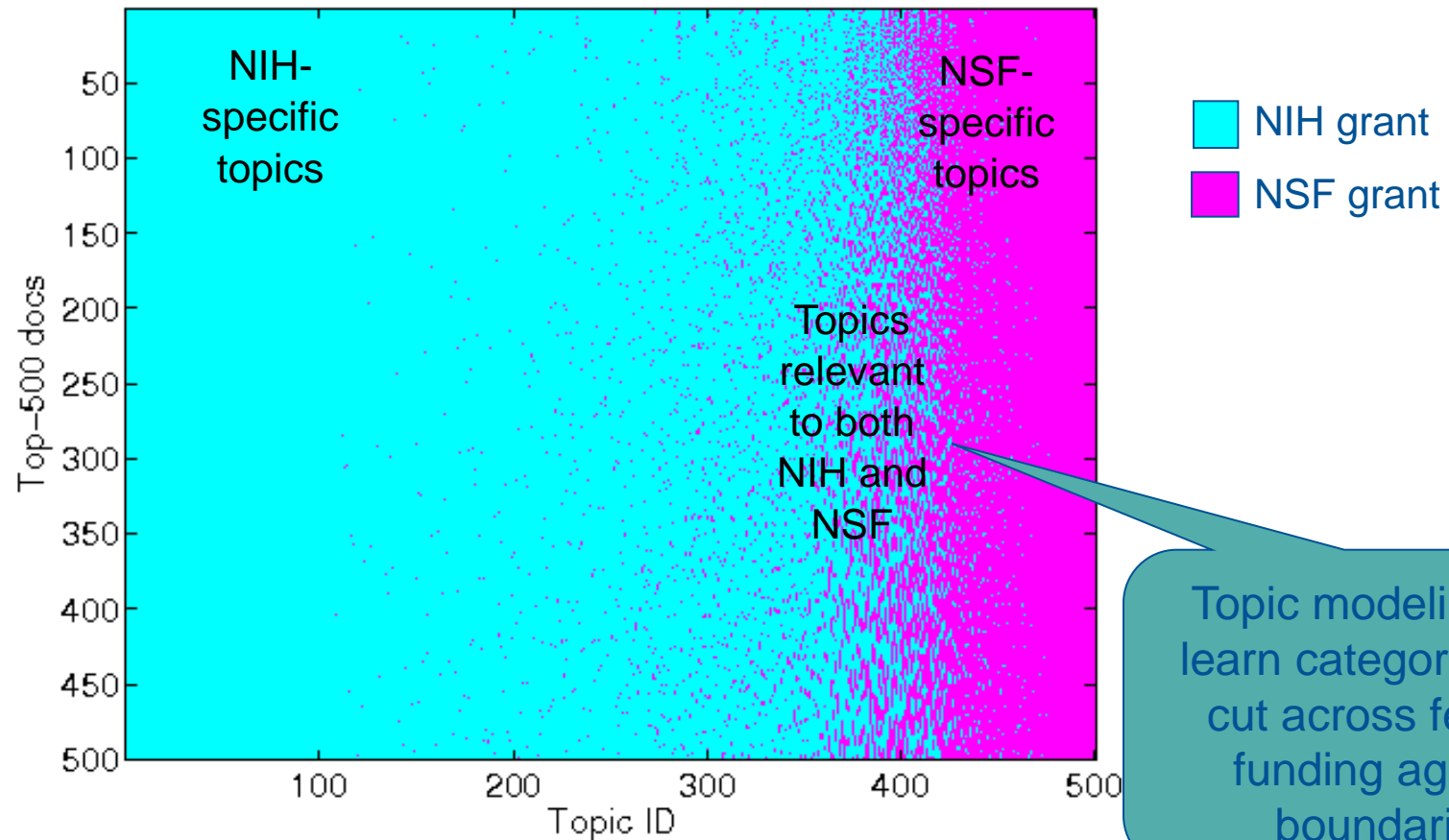
- 1000 topics learned from 200k submitted NSF proposals

Topics ideal for research portfolio analysis

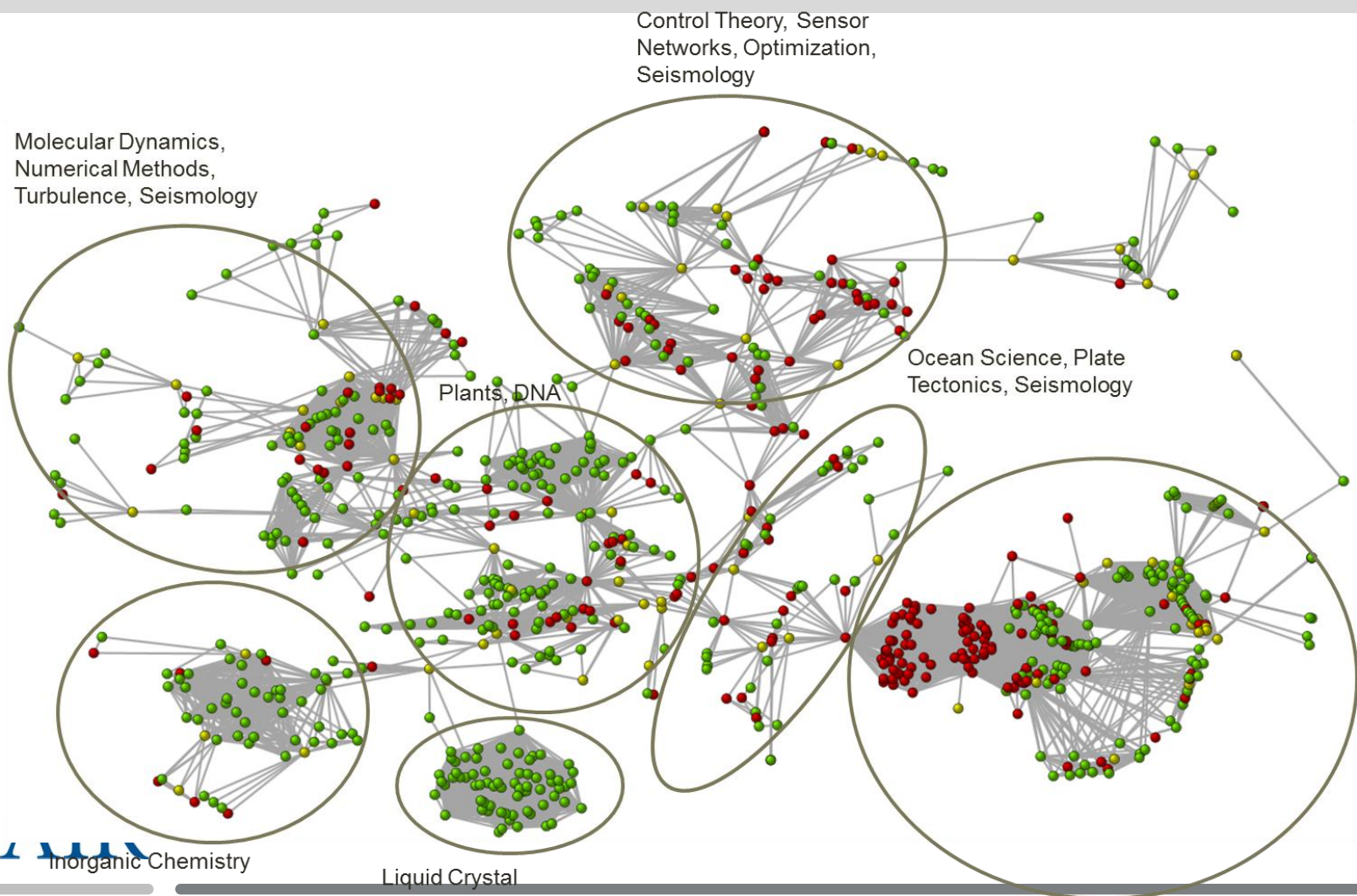
Measure relationship between research investment and research outcomes (publications, patents)

Topic model unifies research categories across funding agencies and document genre

Tools to capture level of funding



Combine tools and data to capture networks



Inorganic Chemistry

Liquid Crystal

Outline

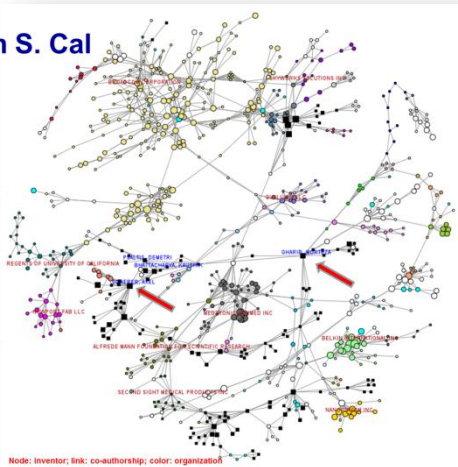
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Engage analytical community

- Patent Network Dataverse Lee Fleming Harvard
- COMETS (Connecting Outcome Measures in Entrepreneurship Technology and Science): Lynne Zucker and Michael Darby UCLA
- Randomized Controlled Trials John Willinsky, Stanford

1st LCC in S. Cal

- Broadcom: networking and communications ICs for data, voice, and video applications
- Medtronic
- Univ. of California
- Belkin Int'l: computer connectivity hardware
- Second Sight: retinal prosthesis (cybernetic eyeglasses)
- Alfred Mann Foundation: fund prosthetic service research



COMETS

Integrating the STARS with the universe to advance entrepreneurship and innovation

- Home
- About COMETS
- Codebook
- Cooperating Scholars
- Data Files
- FAQs
- Funding Opportunities
- Announcements
- Contact Us
- Reference Guidelines

Connecting Outcome Measures in Entrepreneurship, Technology, and Science (COMETS)

One of the greatest impediments to rapid progress in the science of science and innovation policy—both as a field of study and as a guide to policy—is data. Researchers Lynne G. Zucker and Michael R. Darby of the University of California, Los Angeles, and the National Bureau of Economic Research along with a large team of cooperating scholars, have created an integrated database that can trace the links from government investment in R&D through the path of knowledge creation, to transmission and codification, and in many cases to commercial uses yielding a better standard of living and better jobs.

The Connecting Outcome Measures in Entrepreneurship Technology and Science or COMETS database is now available to researchers looking to explore these connections. The COMETS database integrates and complements key databases on science and innovation by using a system of unique identifiers for firms and other organizations and for individual scientists and engineers who serve as principal investigators, dissertation writers or advisors, inventors, and/or firm officers, directors, and key employees. The COMETS database integrates data on government grants, dissertations, patents, and publicly available firm data. The first phase now available covers only grants and patents. Other data will be added as integrated into COMETS.

COMETS provides a shared database that enables work to be done that would otherwise be impossible for researchers not located at one of the few elite institutions where significant parts of COMETS are available.

Download the Version 1.0 data today or start by reading the codebook that describes the data and fields available for scholars currently. COMETS 1.0 contains an integrated set of data files in STATA and also as a flat file with U.S. patent, NSF and NIH data.

Announcements

Travel Grants Available!
Academic researchers presenting research papers that use the COMETS database may apply for travel funding to cover airfare and hotel expenses for academic conferences.

NSF Award Search - Award Information

Search Results: 100% Match

Sorted by award date, with the most recent awards at the top. Click on a column heading to re-sort the results. Down arrows at the right of each column title control whether the sort is ascending or descending. To abstract, click on the award number or title. Click on the data in other columns to perform a new search with that parameter.

Found, displaying all awards.

Title	NSF Organization	Program(s)	Start Date	Principal Investigator	State	Organization	Awarded Amount to Date
The NRI Public Access Policy: Potential Impact on Physics and Community Health Organizations	SMA	SCIENCE OF SCIENCE POLICY	06/01/2012	Willinsky, John	CA	Stanford University	\$381,878.00
Establishing a Basis for Assessing a Science Policy	SMA	SCIENCE OF SCIENCE POLICY	08/01/2010	Willinsky, John	CA	Stanford University	\$71,778.00

options: CSV | Excel | XML

Web browsers allow you to save the exported file by right-clicking on the link and choosing "save link target" from the menu options. See the [help](#) for more information.

Build on key ideas

Extend Conceptual Framework

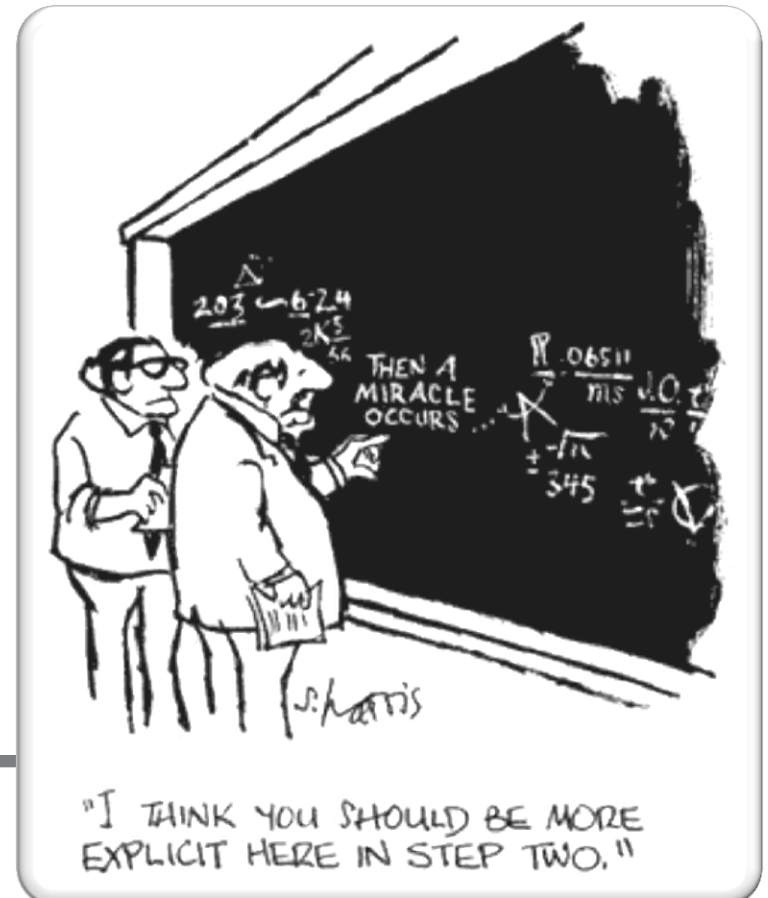
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Extend Empirical Framework

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And a reminder of why!

Competing Priorities in the Federal Budget...



Thank you!

Comments and questions?

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